PUTTING RESEARCH TO WORK BRIEF

Improving Asphalt Overlay Design Through Deflection Testing

A standard method of squeezing more serviceable years from cracking or rutting asphalt pavement roadways is to lay a new asphalt surface over the old. Such flexible pavement overlays can improve deteriorated pavement and enhance skid resistance, ride quality, and other functional characteristics of the roadway. The overlays can also add structural capacity—valuable when engineers anticipate an increase in traffic loading.

A critical element of overlay design is thickness. Policy decisions, engineering judgment, and the desire to limit fatigue damage or improve structural integrity typically drive thickness design, a practice firmly rooted in empirical methodology.

What's the Problem?

Like many state DOTs, Wisconsin DOT uses very few mechanistic methods to design asphalt overlays of existing asphalt pavements. Unlike neighboring states, which use newer methods, WisDOT bases its overlay design on 1972 AASHTO pavement design guide procedures. Designers assign structural numbers to existing pavements, then add overlays to achieve a higher number—an earlier version of the Structural Deficiency Approach described below.

The lack of mechanistic guidance for quantifying the structural integrity of existing flexible pavements hinders effective performance enhancement and materials management. Even if two existing pavement sections show similar distress and share the same design, WisDOT's uneven, empirically dependent overlay procedures may result in very different overlay thicknesses for the two sections.

Research Objectives

This research aimed to produce consistent, objective methods for determining the appropriate thickness of asphalt overlays to increase the structural capacity of existing asphalt pavements. The recommended procedures should be compatible with current WisDOT pavement design methods, and use pavement performance data commonly collected in Wisconsin. Specific objectives included:

- Developing a procedure for quantifying the effective structural capacity of existing flexible pavements, including guidelines for data collection.
- Recommending design procedures for asphalt overlays of flexible pavements.

Methodology

The researcher thoroughly reviewed relevant literature and surveyed practices at five Midwest state transportation agencies, identifying key pavement performance data elements to include in revised overlay design procedures for WisDOT.

Results

This research found that three approaches dominate overlay design practice in this country. From most common to least, they are:

1. Structural Deficiency Approach. Based largely on methodology in the 1993 AASHTO pavement design guide, this procedure treats overlay structural impact in terms of effective structural numbers by adding the value of the overlay structure to the value of the original pavement design, as if the overlay were part of the as-built structure.

Indiana DOT employs this method, but relies on visual inspection to identify overlay need, and engineering judgment to determine thickness. A falling weight deflectometer may be used to establish both the effective structural number of the existing pavement and the design subgrade resilient modulus.

Investigator

"We found that WisDOT can improve its overlay design practices by using well-understood measures of deflection and pavement conditions."

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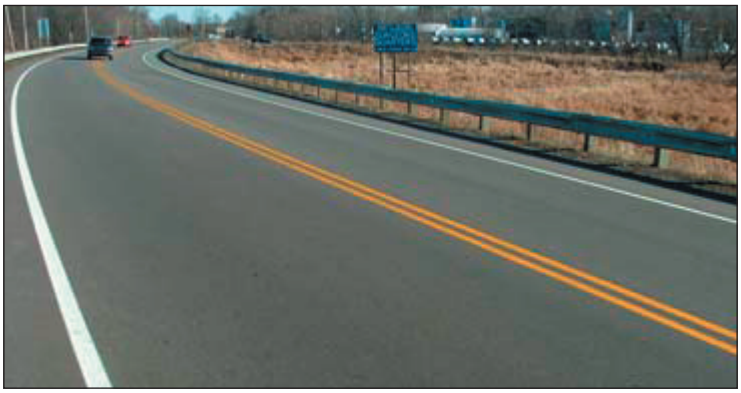

Asphalt overlays like the one on this highway can extend a pavement's service life and add structural capacity. This study recommends incorporating deflection testing into overlay design.

Iowa DOT also employs this method, supplemented by its own version of the Maximum Deflection Approach (described below). Michigan DOT also uses a version of this method, modified by department policy. MDOT uses the 1993 AASHTO design guide to establish structural overlay requirements.

2. Maximum Deflection Approach. Relying on correlation of total pavement deflection with pavement service life, engineers select overlay thickness to reduce deflections to acceptable levels based on projected loading. The most widely used methodology was developed by the Asphalt Institute.

Illinois and Minnesota DOTs use this method, measuring surface deflection with FWDs. IDOT incorporates temperature and season adjustments, soil type, and other factors into analytical data. Mn/DOT uses its own software and considers budget constraints in determining overlay thickness.

3. Limiting Fatigue Damage Approach. Gaining increasing attention, this mechanistic method involves stress-strain analysis of existing pavement structures. Engineers use this analysis to estimate remaining service life in terms of fatigue cracking or rutting, and select overlay thickness based on anticipated traffic loading in order to limit such distress.

Recommendations

Until the new AASHTO Mechanistic-Empirical Pavement Design Guide can be adopted, the investigator recommends that WisDOT revise its current practice of using 1972 AASHTO design guide structural number concepts to include an effective structural number assessment procedure. Other recommendations include:

• WisDOT should revise its overlay design procedures to include pavement condition and surface deflection measures, allowing for independent as well as integrated use of these measures.

• WisDOT should use deflection testing to establish effective structural numbers for all but lightly trafficked pavement sections. When deflection data is not available, WisDOT should establish effective structural numbers based on pavement condition measures (ride quality and distress) and the pavement's original structural number.

Implementation and Benefits

By implementing these recommendations, WisDOT will develop overlay design procedures compatible with current WisDOT design methods while providing a transition to the AASHTO mechanistic-empirical design guide. WisDOT will be using commonly collected performance data to create more technically sound overlays for extending service life and maximizing the use of available materials.

This brief summarizes Project 0092-00-05, "Development of Rational Overlay Design Procedures for Flexible Pavements," produced through the Wisconsin Highway Research Program for the Wisconsin Department of Transportation Research, Development & Technology Transfer Program, 4802 Sheboygan Ave., Madison, WI 53707.

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Project Manager

"The study points us in the direction of a mechanistic method for designing asphalt overlays. It helps us maximize our materials and data to get longer lives out of structural overlays."

–Len Makowski
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